

CLAIMS

1. A method of forming a threaded hole in a hydroformed part while the part remains in a hydroforming die cavity, said method comprising the steps of piercing a hole in the part while hydroforming pressure is maintained therein, extruding an annular region of the part about the hole to a predetermined depth inward of the part, expanding the interior of the extruded annular region to a predetermined inner diameter determined by a thread required to be formed therein by material displacement, and forming a thread in the interior of the extruded and expanded annular region in a material displacing manner.
2. A method as defined in claim 1 using a single tool to perform the piercing, extruding, expanding and thread forming operations.
3. A method as defined in claim 2 wherein the tool is fed at a feed rate equal to the pitch of the required thread to form the thread and is retracted at the same rate but in an opposite axial and rotational direction to remove the tool from the formed thread.
4. A method as defined in claim 2 wherein the tool is fed without rotation in performing the piercing, extruding, and expanding operations.
5. A method as defined in claim 2 wherein the tool is fed and rotated in performing the piercing, extruding, and expanding operations.
6. Apparatus having a tool adapted to form a threaded hole in a hydroformed part while the part remains in a hydroforming die cavity, said tool comprising a hole-piercing end portion adapted on advancement of the

5 tool to pierce and form a hole in the part while hydroforming fluid under pressure remains in the part, an extruding portion adapted on continued tool advancement to extrude an annular region of the part extending about the hole to a predetermined depth inward of the part, an expanding portion adapted on continued tool advancement to expand the hole in the extruded annular region to a predetermined diameter determined by a thread to be
 10 formed therein by material displacement, and a thread forming portion adapted on continued tool advancement to form a thread in the extruded and expanded annular region of the part by material displacement.

7. Apparatus as set forth in claim 6 wherein the hole- piercing end portion of the tool has a pointed end with an adjoining faceted surface and a cylindrical surface adjoining the faceted surface.

8. Apparatus as set forth in claim 6 wherein the hole- piercing end portion of the tool has a pointed end with an adjoining conical surface, and a cylindrical surface adjoining the conical surface.

9. Apparatus as set forth as set forth in claim 6 wherein the hole- piercing end portion of the tool has a blunt end with a flat area of sufficient size to prevent premature piercing and a circular edge intersected at an acute angle to the flat area of the blunt end by a flat chamfer of limited annular
 5 extent, and a cylindrical surface adjoining the blunt end wherein the chamfer also intersects the cylindrical surface.

10. Apparatus as set forth in claim 6 wherein the extruding portion of the tool has a conical surface diverging radially outwardly from the hole-piercing end portion.

11. Apparatus as set forth in claim 6 wherein the extruding

portion of the tool has a concave-convex annular surface extending from the hole-piercing end portion.

12. Apparatus as set forth in claim 6 wherein the expanding portion of the tool has a partial thread and the thread forming portion has a full thread with the same pitch as and a larger major diameter than the partial thread.

13. Apparatus as set forth in claim 12 wherein the tool has a relief portion between the partial thread and the full thread having a maximum diameter less than the minor diameter of the partial thread and the full thread.

14. Apparatus as set forth claim 6 further including an actuator device adapted to advance the tool to perform the piercing and extruding and expanding operations, rotate the tool in one direction while advancing the tool to form the thread at a feed rate equal to the pitch of the partial and full
5 thread, and rotate the tool in the opposite direction while retracting the tool at the same rate in order to release the tool from the formed thread without the partial thread disturbing the formed thread.

15. Apparatus as set forth in claim 14 wherein the actuator device is also adapted to rotate the tool in performing the piercing and extruding and expanding operations.

16. Apparatus as set forth in claim 13 wherein the actuator is also adapted to feed the tool at variable linear feed rates while performing the piercing and extruding and expanding operations and also retract the tool at variable linear rates following the piercing and extruding and expanding
5 operations.